GPIB-232CV
User Manual

IEEE 488 ↔ RS-232 Converter

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This equipment generates and uses radio frequency energy and, if not installed and used in strict accordance with the instructions in this manual, may cause interference to radio and television reception. This equipment has been tested and found to comply with the following two regulatory agencies:

Federal Communications Commission

This device complies with Part 15 of the Federal Communications Commission (FCC) Rules for a Class A digital device. Operation is subject to the following two conditions:

1. This device may not cause harmful interference in commercial environments.

2. This device must accept any interference received, including interference that may cause undesired operation.

Canadian Department of Communications

This device complies with the limits for radio noise emissions from digital apparatus set out in the Radio Interference Regulations of the Canadian Department of Communications (DOC).

Le présent appareil numérique n'émet pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques de classe A prescrites dans le règlement sur le brouillage radioélectrique édicté par le ministère des communications du Canada.

Instructions to Users

These regulations are designed to provide reasonable protection against harmful interference from the equipment to radio reception in commercial areas. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense.

There is no guarantee that interference will not occur in a particular installation. However, the chances of interference are much less if the equipment is installed and used according to this instruction manual.

If the equipment does cause interference to radio or television reception, which can be determined by turning the equipment on and off, one or more of the following suggestions may reduce or eliminate the problem.

- Operate the equipment and the receiver on different branches of your AC electrical system.
- Move the equipment away from the receiver with which it is interfering.
- Reorient or relocate the receiver's antenna.
- Be sure that the equipment is plugged into a grounded outlet and that the grounding has not been defeated with a cheater plug.

Notice to user: Changes or modifications not expressly approved by National Instruments could void the user's authority to operate the equipment under the FCC Rules.

If necessary, consult National Instruments or an experienced radio/television technician for additional suggestions. The following booklet prepared by the FCC may also be helpful: *How to Identify and Resolve Radio-TV Interference Problems.* This booklet is available from the U.S. Government Printing Office, Washington, DC 20402, Stock Number 004-000-00345-4.

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About This Manual

The *GPIB-232CV User Manual* describes the features, functions, and operation of the Product. The GPIB-232CV is one of National Instruments family of MicroGPIB products. These products are high-performance, low-cost IEEE 488 support items, packaged in small all-metal cases, capable of being rack mounted.

Organization of This Manual

The *GPIB-232CV User Manual* is organized as follows:

- Chapter 1, *Description of the GPIB-232CV*, contains a brief overview of the GPIB-232CV, lists the contents of your kit and optional equipment, and describes the panels of the GPIB-232CV.
- Chapter 2, *Configuration and Installation*, describes the procedures for configuring and installing the GPIB-232CV.
- Chapter 3, *Operation*, contains information about operating the GPIB-232CV in D mode or C mode and information about data buffering and handshaking.
- Appendix A, *Hardware Specifications*, lists the electrical, environmental, and physical specifications of the GPIB-232CV.
- Appendix B, *Interfacing to a Serial Device*, contains information about the RS-232 port and how to connect the GPIB-232CV to your serial device. This information is useful if you want to build your own serial cable.
- Appendix C, *Application Examples*, contains an example showing how to use a GPIB-232CV as a high-speed print spooler and an example showing how to use a GPIB-232CV to interface a HP7475 plotter to a computer running AUTOCAD.
- Appendix D, *Customer Communication*, contains forms you can use when requesting help from National Instruments or to comment on our products and manuals.

- The *Glossary* contains an alphabetical list and description of terms used in this manual including abbreviations, acronyms, metric prefixes, mnemonics, and symbols.

Conventions Used in This Manual

The following conventions are used in this manual:

italic	Italic text denotes emphasis, a cross reference, or an introduction to a key concept.
`monospace`	Text in this font denotes text or characters that are to be literally input from the keyboard, sections of code, programming examples, syntax examples, and names of variables.
bold	Bold text in this manual denotes a signal name or a front panel LED indicator.
<>	Angle brackets enclose the ASCII character symbols for certain keystrokes. For example, <CR> for carriage return and <LF> for linefeed.
-	A hyphen between two or more key names enclosed in angle brackets denotes that you should simultaneously press the named keys–for example, <Control-Alt-Delete>.
IEEE 488 and IEEE 488.2	IEEE 488 and IEEE 488.2 are used throughout this manual to refer to the ANSI/IEEE Standard 488.1-1987 and the ANSI/IEEE Standard 488.2-1987, respectively, which define the GPIB.
RS-232	RS-232 is used throughout this manual to refer to the ANSI/EIA-232-C standard.

Abbreviations, acronyms, metric prefixes, mnemonics, and terms are listed in the *Glossary*.

Related Documentation

The following documents contain information that you may find helpful as you read this manual:

- ANSI/EIA-232, *Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange.*
- ANSI/IEEE Standard 488.1-1987, *IEEE Standard Digital Interface for Programmable Instrumentation.*
- ANSI/IEEE Standard 488.2-1987, *IEEE Standard Codes, Formats, Protocols, and Common Commands.*

Customer Communication

National Instruments wants to receive your comments on our products and manuals. We are interested in the applications you develop with our products, and we want to help if you have problems with them. To make it easy for you to contact us, this manual contains comment and configuration forms for you to complete. These forms are in Appendix D, *Customer Communication*, at the end of this manual.

Chapter 1
Description of the GPIB-232CV

This chapter contains a brief overview of the GPIB-232CV, lists the contents of your kit and optional equipment, and describes the panels of the GPIB-232CV.

Introduction

The GPIB-232CV, shown in Figure 1-1, provides a method of connecting a device with a RS-232 port to the GPIB, or IEEE 488, bus. The GPIB-232CV transparently converts data between the two ports so that control codes or special commands are not required. The GPIB-232CV also increases the efficiency of the interface system by isolating the slower device from the faster port with a 256 KB character buffer. This buffer is used to offload the host computer during printer and plotter applications.

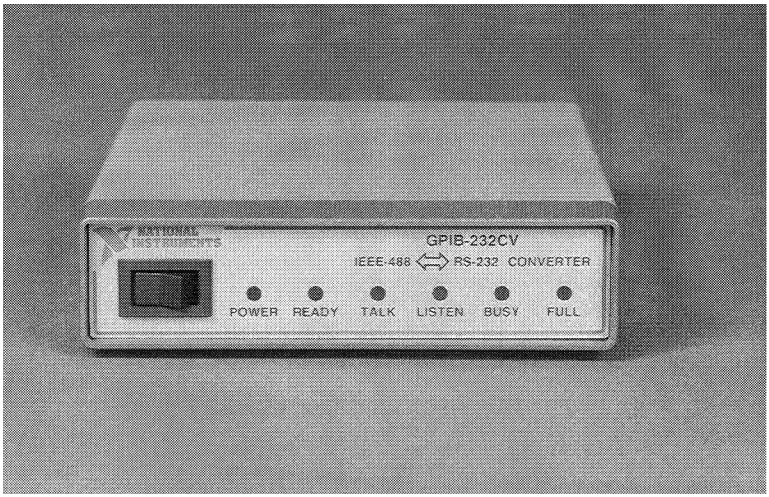

Figure 1-1. The GPIB-232CV

The GPIB-232CV is capable of interfacing either a GPIB Controller or a GPIB device to a computer or instrument with a RS-232 port. It can be used to interface a GPIB device to a computer with a RS-232 port or to connect a RS-232 device such as a printer or plotter to a GPIB network. Data transfers in either direction are possible at all times.

What Your Kit Contains

Your kit should contain the following components:

Component	Part Number
One of the following boxes:	
• GPIB-232CV (256 KB RAM - 115 VAC)	776174-02
• GPIB-232CV (256 KB RAM - 230 VAC)	776174-32
GPIB-232CV User Manual	320109-01

Optional Equipment

Component	Part Number
Rack mount Kit:	
Single (1 unit)	180480-01
Dual (2 units)	180480-02
RS-232 Shielded Cable, Compatible with IBM PC	
DTE to DTE - 1 m	181074-10
25-pin male D-sub to 9-pin female D-sub	
Double-Shielded GPIB Cables:	
GPIB Type X2 Cable – 1 m	763061-01
GPIB Type X2 Cable – 2 m	763061-02
GPIB Type X2 Cable – 4 m	763061-03

The GPIB-232CV Front Panel

The front panel of the GPIB-232CV is shown in Figure 1-2. The power switch and six light-emitting diodes (LEDs) are mounted on the GPIB-232CV front panel.

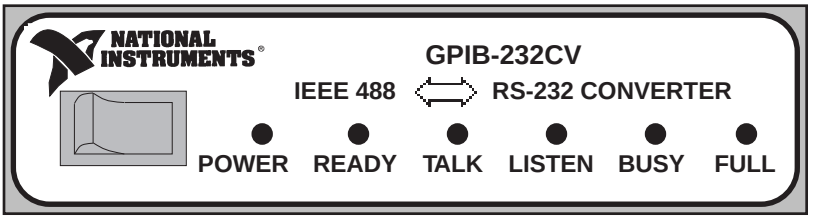

Figure 1-2. The GPIB-232CV Front Panel

The LEDs show the current status of the GPIB-232CV at all times. Table 1-1 describes each LED.

Table 1-1. LED Descriptions

LED	Indication
POWER	Indicates that power to the unit has been applied and the ON/OFF switch is in the ON position.
READY	Indicates that the power-on self-test has passed successfully and the unit is ready to operate.
TALK	Indicates that the GPIB-232CV is configured as a GPIB Talker.
LISTEN	Indicates that the GPIB-232CV is configured as a GPIB Listener.
BUSY	Indicates that the GPIB-232CV is currently accepting serial data. Each serial character received toggles the status of the **BUSY** LED.
FULL	Indicates that one of the GPIB-232CV data buffers is full. This is not an error condition, but is merely a signal that bus performance may be reduced to the speed of the slower interface.

The GPIB-232CV Rear Panel

The power cord, serial cable, and GPIB cable connections are on the rear panel. Figure 1-3 shows the rear panel of the GPIB-232CV.

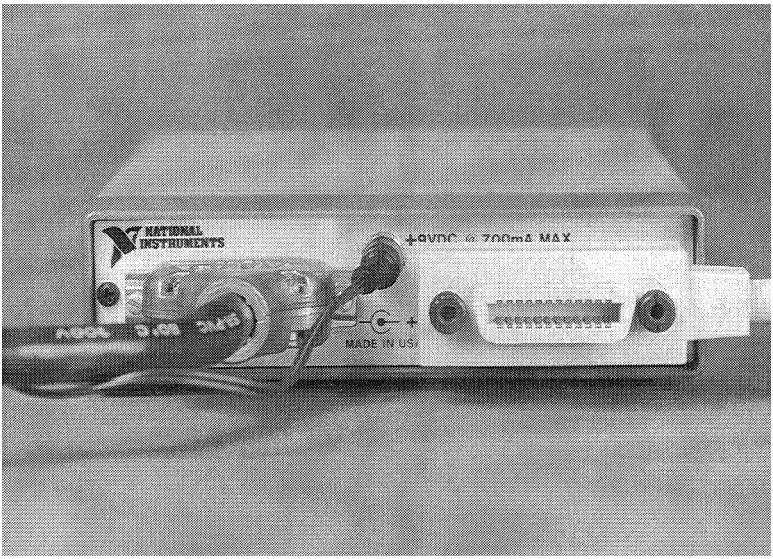

Figure 1-3. The GPIB-232CV Rear Panel

The RS-232 Connector

The RS-232 port on the GPIB-232CV is configured as a DTE (Data Terminal Equipment) and uses a standard 25-pin shielded D-subminiature female connector with screwlock assemblies. The RS-232 connector will accept standard 25-pin D-subminiature male connectors. A diagram of the serial connector and the signals supported is shown in Figure 1-4. For more information on the RS-232 signals refer to Appendix B, *Interfacing to a Serial Device*.

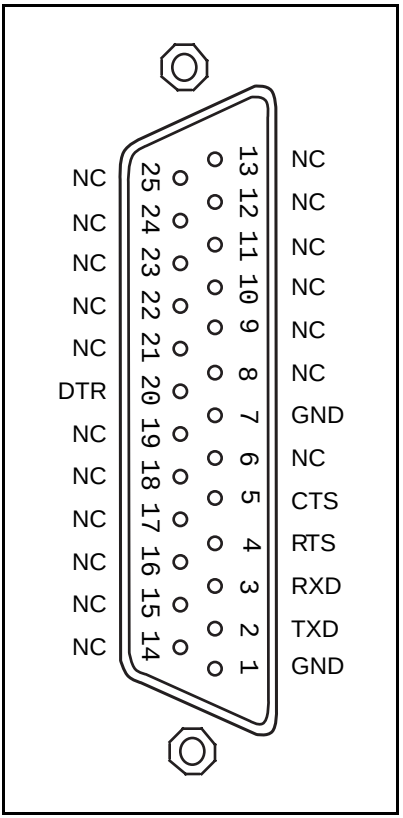

Figure 1-4. The RS-232 Connector and Signal Designations

The GPIB Connector

The GPIB connector is a standard 24-pin shielded AMP Champ female connector with metric screwlock hardware. A diagram of the GPIB connector and the signals supported is shown in Figure 1-5 (a * suffix indicates that the signal is active low).

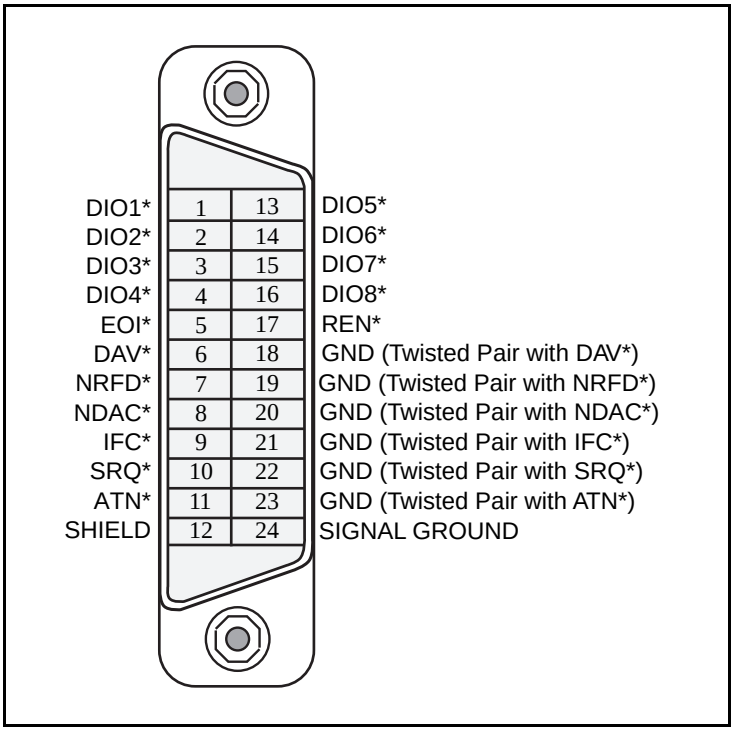
DIO1* 1 13 DIO5*
DIO2* 2 14 DIO6*
DIO3* 3 15 DIO7*
DIO4* 4 16 DIO8*
EOI* 5 17 REN*
DAV* 6 18 GND (Twisted Pair with DAV*)
NRFD* 7 19 GND (Twisted Pair with NRFD*)
NDAC* 8 20 GND (Twisted Pair with NDAC*)
IFC* 9 21 GND (Twisted Pair with IFC*)
SRQ* 10 22 GND (Twisted Pair with SRQ*)
ATN* 11 23 GND (Twisted Pair with ATN*)
SHIELD 12 24 SIGNAL GROUND

Figure 1-5. The GPIB Connector and Signal Designations

Chapter 2
Configuration and Installation

This chapter describes the procedures for configuring and installing the GPIB-232CV.

As mentioned in Chapter 1, the GPIB-232CV can be configured either as a GPIB Controller capable of addressing a single GPIB device to talk or listen, or as a GPIB device that can be addressed to talk or listen by a GPIB Controller.

Choosing Between D Mode or C Mode

When transferring data to or from a GPIB device that has no controller capabilities, the GPIB-232CV should be set to operate in the Controller (C) mode. This is because in a GPIB system there must exist at least one Controller that is responsible for addressing the instruments on the bus to talk and listen. In this mode the GPIB-232CV, upon power-up, will assert Interface Clear (IFC) and address the GPIB instrument using the GPIB primary address set on the configuration switches. An example of a system operating in C mode is a GPIB device, such as a digital multimeter, connected to an IBM PC serial port through a GPIB-232CV.

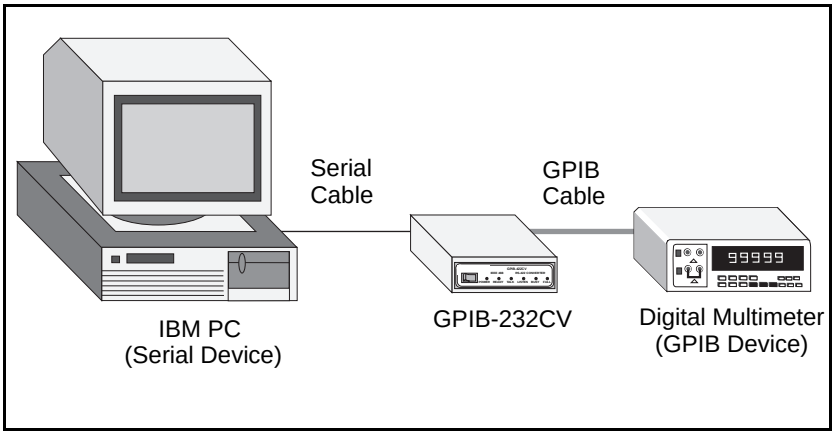

Figure 2-1. Example of C Mode System Setup

If your system has a GPIB Controller that is responsible for addressing the GPIB-232CV to talk or listen, the GPIB-232CV should be set to operate in the Device (D) mode. It is called the Device mode because the GPIB-232CV functions like another GPIB device.

An example of a system operating in D mode is a RS-232 device, such as a serial printer, connected to a GPIB system with an existing GPIB Controller, such as an IBM PC with a National Instruments AT-GPIB board, as shown in Figure 2-2.

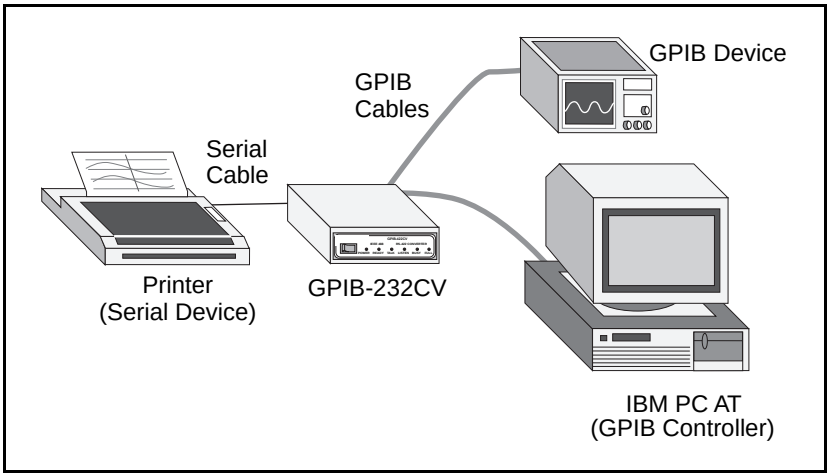

Figure 2-2. Example of D Mode System Setup

Installation

Install the GPIB-232CV according to the following procedure.

1. Inspect the GPIB-232CV for damage that may have been caused in shipment.
2. Verify the voltage requirement.
3. Configure the operating parameters.
4. Connect the cables.
5. Power on the unit.

Step 1. Inspection

Before you install the GPIB-232CV, inspect the shipping container and its contents for damage. If damage appears to have been caused in shipment, file a claim with the carrier. Retain the packing material for possible inspection and/or reshipment.

If the equipment appears to be damaged, do not attempt to operate it. Contact National Instruments for instructions.

Step 2. Verify the Voltage Requirement

The GPIB-232CV is shipped from the factory with either a 115V or 230V wall-mount supply. Verify that the voltage on the supply matches the voltage that is supplied in your area.

Warning: ***Operating the unit at any voltage other than the one specified could damage the unit.***

Step 3. Configure the Operating Parameters

The GPIB-232CV is shipped from the factory configured to operate in D mode and is set to GPIB primary address 5. The serial port is configured at 9600 baud, 1 stop bit, no parity, and 7 data bits with XON/XOFF protocol disabled. If you wish to change any of the GPIB-232CV parameters, you must open the unit and set the configuration switches. To change the configuration switches follow these steps:

1. Disconnect power to the unit and disconnect any cables that may be connected to the unit.

2. Unscrew the two screws on the opposite sides of the rear panel.

3. Grab the rear panel bezel and pull it straight away from the rest of the unit. The card should slide out the back of the enclosure.

4. Locate the configuration DIP switches (U20 and U22) on the printed wire board.

5. Set the switches for the desired mode of operation, as described in the following section, *Set Configuration Switches*.

Warning: ***Most of the circuitry in the GPIB-232CV uses advanced CMOS technology and can be damaged by static electricity. Avoid touching any of the components and take any necessary CMOS handling precautions.***

6. Close the unit and re-insert the screws removed in Step 2.

Set Configuration Switches

The DIP switches at location U20 and U22 on the printed wire board are used to configure the GPIB-232CV. The DIP switch at location U22 is used to configure the mode of the GPIB-232CV as well as the address of the GPIB device. The DIP switch, shown in Figure 2-3, has eight configuration switches.

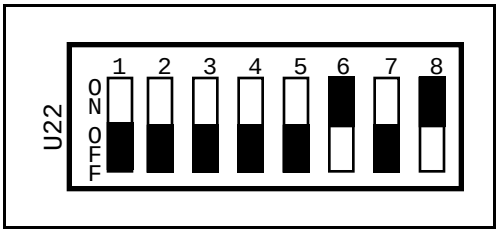

Figure 2-3. Factory Default Settings for Switch U22

Figure 2-3 shows the GPIB-232CV's factory default settings for switch U22. Switch 1 is in the OFF position; this indicates that the unit is configured to operate in D mode. Switches 2 and 3 are in the OFF position; this indicates that SRQ is disabled and the small serial buffer is selected. Switches 4 through 8 are in the OFF OFF ON OFF ON positions, respectively; this indicates a GPIB primary address of 5.

Tables 2-1, 2-2, and 2-3 show the possible configurations of the eight switches and what the configurations indicate.

Default settings are in shaded rows.

Table 2-1. Configuration Parameters for U22 Switch 1

Switch 1 Position	Indication
OFF	GPIB-232CV operates in D mode.
ON	GPIB-232CV operates in C mode.

Table 2-2. Configuration Parameters for U22 Switches 2 and 3

Switches 2	Switches 3	Indication D Mode	Indication C Mode
OFF	OFF	Small serial buffer and disable SRQ	Time-out termination
OFF	ON	Small serial buffer and enable SRQ	CR termination
ON	OFF	Large serial buffer and disable SRQ	LF termination
ON	ON	Large serial buffer and enable SRQ	No swapping

Table 2-3. Configuration Parameters for U22 Switches 4 through 8

Switches					Indication
4	**5**	**6**	**7**	**8**	
OFF	OFF	OFF	OFF	OFF	GPIB Primary Address 0
OFF	OFF	OFF	OFF	ON	GPIB Primary Address 1
OFF	OFF	OFF	ON	OFF	GPIB Primary Address 2
OFF	OFF	OFF	ON	ON	GPIB Primary Address 3
OFF	OFF	ON	OFF	OFF	GPIB Primary Address 4
OFF	OFF	ON	OFF	ON	GPIB Primary Address 5
OFF	OFF	ON	ON	OFF	GPIB Primary Address 6
OFF	OFF	ON	ON	ON	GPIB Primary Address 7
OFF	ON	OFF	OFF	OFF	GPIB Primary Address 8
OFF	ON	OFF	OFF	ON	GPIB Primary Address 9
OFF	ON	OFF	ON	OFF	GPIB Primary Address 10
OFF	ON	OFF	ON	ON	GPIB Primary Address 11
OFF	ON	ON	OFF	OFF	GPIB Primary Address 12
OFF	ON	ON	OFF	ON	GPIB Primary Address 13
OFF	ON	ON	ON	OFF	GPIB Primary Address 14
OFF	ON	ON	ON	ON	GPIB Primary Address 15
ON	OFF	OFF	OFF	OFF	GPIB Primary Address 16
ON	OFF	OFF	OFF	ON	GPIB Primary Address 17
ON	OFF	OFF	ON	OFF	GPIB Primary Address 18
ON	OFF	OFF	ON	ON	GPIB Primary Address 19
ON	OFF	ON	OFF	OFF	GPIB Primary Address 20
ON	OFF	ON	OFF	ON	GPIB Primary Address 21
ON	OFF	ON	ON	OFF	GPIB Primary Address 22

Table 2-3. Configuration Parameters for U22 Switches 4 through 8 (continued)

Switches					Indication
4	**5**	**6**	**7**	**8**	
ON	OFF	ON	ON	ON	GPIB Primary Address 23
ON	ON	OFF	OFF	OFF	GPIB Primary Address 24
ON	ON	OFF	OFF	ON	GPIB Primary Address 25
ON	ON	OFF	ON	OFF	GPIB Primary Address 26
ON	ON	OFF	ON	ON	GPIB Primary Address 27
ON	ON	ON	OFF	OFF	GPIB Primary Address 28
ON	ON	ON	OFF	ON	GPIB Primary Address 29
ON	ON	ON	ON	OFF	GPIB Primary Address 30
ON	ON	ON	ON	ON	Sets listen-only operation (D mode) or no addressing performed (C mode)

The DIP switch at location U20 on the printed wire board is used to configure the serial port parameters of the GPIB-232CV. The DIP switch, shown in Figure 2-4, has eight configuration switches.

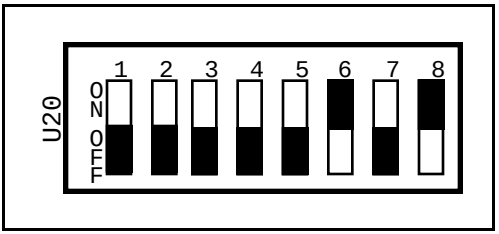

Figure 2-4. Factory Default Settings for Switch U20

On DIP switch U20, switch 1 is OFF, indicating that XON/XOFF is disabled. Switch 2 is OFF, indicating that the GPIB-232CV will be using 7 bits/character for its serial data transfers. Switch 3 is OFF, which indicates 1 stop bit per character. Switches 4 and 5 are both OFF, which indicates that parity is disabled. Switches 6 through 8 are in the ON OFF ON positions, respectively, indicating that the serial port will be operating at 9600 baud.

Tables 2-4 and 2-5 show the possible configurations of the eight switches and what the configurations indicate.

Table 2-4. Configuration Parameters for U20 Switches 1 through 5

Switch	Position	Indication
1	OFF ON	XON/XOFF protocol disabled XON/XOFF protocol enabled
2	OFF ON	7 bits/character 8 bits/character
3	OFF ON	1 stop bit/character 2 stop bits/character
4	OFF ON	parity generation/checking disabled parity generation/checking enabled
5	OFF ON	odd parity even parity

Table 2-5. Configuration Parameters for U20 Switches 6 through 8

Switches 6	7	8	Indication
OFF	OFF	OFF	300 baud
OFF	OFF	ON	600 baud
OFF	ON	OFF	1200 baud
OFF	ON	ON	2400 baud
ON	OFF	OFF	4800 baud
ON	OFF	ON	9600 baud
ON	ON	OFF	19200 baud
ON	ON	ON	38400 baud

Step 4. Connect the Cables

Connect the cables as follows:

1. Connect the serial cable to the GPIB-232CV and securely fasten the holding screws. Connect the other end of the cable to your serial device. Be sure to use only shielded serial cable, and follow all RS-232 cabling restrictions.

2. Connect the GPIB cable to the GPIB-232CV and tighten the thumb screws on the connector. Connect the other end to your GPIB system. Be sure to follow all IEEE 488 cabling restrictions, and use only double-shielded GPIB cable.

3. Connect the power jack of the wall-mount power supply to the power receptacle on the back panel of the GPIB-232CV, then plug the supply into an AC outlet of the correct voltage.

Step 5. Power on the Unit

Power on your GPIB-232CV by using the front panel rocker switch. The **POWER** LED should come on immediately. The **READY** indicator should come on after the GPIB-232CV has passed its power-on self-test, indicating the unit is ready for operation.

If the **READY** indicator does not come on within seven seconds after the unit is powered on, recheck all connections and switch settings and retry the power-on sequence. If the **READY** light still fails to come on, contact National Instruments for further instructions.

Operation

The GPIB-232CV is now ready to operate. All characters sent to the unit will be received at full speed and stored in the internal data buffer. The characters will be sent to the receiving device at the rate of the receiving device.

If using the GPIB-232CV in C mode, turn on the GPIB instrument before turning on the GPIB-232CV and be sure the configuration switches are set correctly. When the GPIB-232CV is powered on, it will send IFC and address the instrument to listen. Simply send data to your serial port as you

would if you had a serial device connected to it, and the data will be converted and sent to the GPIB instrument. When the instrument has data to send back, the GPIB-232CV will address the instrument to talk and pass all received data to the RS-232 port.

If using the GPIB-232CV in D mode, simply address the GPIB-232CV to listen (if not in listen-only mode) when you have data to send. All GPIB data received by the GPIB-232CV will be buffered and passed along to the serial device. When you are expecting data from the serial device, address the GPIB-232CV to talk, and all data received over the serial port will then be passed along to the GPIB.

Chapter 3
Operation

This chapter contains information about operating the GPIB-232CV in D mode or C mode and information about data buffering and handshaking.

The GPIB-232CV is actually a powerful 8-bit microcomputer tailored for use as an IEEE 488-to-RS-232 protocol converter. The unit's operating system is contained in Read-Only Memory (ROM) and can address up to 256 KB of dynamic Random-Access Memory (RAM). The GPIB-232CV microprocessor contains an integrated Direct Memory Access (DMA) Controller for high-speed data transfers from the GPIB circuitry. The processor also contains an integrated memory management unit, a dynamic RAM Controller, a clock generator, a programmable timer unit, a full duplex UART (Universal Asynchronous Receiver Transmitter), and an interrupt controller.

The serial port has been designed to be fully compatible with all electrical specifications in the RS-232 standard. All GPIB functionality is provided by an LSI GPIB Controller chip, which is programmed and maintained by the operating system. Both the serial port and the GPIB port are interrupt driven and feature extremely fast response times to external data transfers. For more information on how the individual modes of operation work, refer to the following discussions.

The following terms are specific to the discussions in this chapter:

- A * suffix after a mnemonic indicates negative logic.
- A **boldface** mnemonic indicates that it is a signal name, or a front panel LED indicator.
- <CR> is the symbol for the Carriage Return character (hex 0D).
- <LF> is the symbol for the Linefeed character (hex 0A).

D Mode Operation

In D mode, the GPIB-232CV can act only as a GPIB Talker or Listener. The GPIB-232CV should not be passed control. If it is, the GPIB circuitry in the GPIB-232CV will accept control and immediately assert **ATN***. This is an error condition that can lock up your system and should therefore be avoided.

Data Transfers and Buffering

When operating in D mode, the GPIB-232CV accepts data from the GPIB port using the onboard DMA Controller. The DMA Controller transfers the data directly to the memory buffer without processor intervention. As a result, very high-speed GPIB transfer rates are possible—as high as 900 kbytes/sec. This means that the GPIB system performance will not be degraded by connecting a "slow" printer or plotter to the interface. The buffered data is then dumped to the device on the RS-232 port at its own rate. These two asynchronous events take place concurrently and without user interaction. All operations are completely transparent to the user.

Any serial data that is sent to the GPIB-232CV will be buffered and then passed along to the GPIB port whenever the GPIB-232CV is addressed to talk. Depending upon how much data, if any, is expected to be sent to the GPIB-232CV, via the serial port, two different serial port input buffer sizes can be used for maximum efficiency. The size of the serial input buffer can be set to either 256 bytes (U22 switch 2 set to OFF), or 32 KB (U22 switch 2 set to ON). The serial input buffer size should be set to 256 bytes if only small amounts of data, such as status information, are expected to be sent from the serial device to the GPIB-232CV. The serial input buffer size should probably be set to 32 KB if large amounts of data are expected to be sent from the serial device to the GPIB-232CV, such as an RS-232 instrument sending thousands of bytes of measurements.

Choosing a Serial Port Buffer Size

Whether you use a 256-byte or 32 KB buffer size, the remainder of the RAM space is used as the GPIB input buffer. Thus, if a large amount of GPIB data is expected to be sent to the GPIB-232CV it would be advantageous to use the small serial port buffer size if possible. Remember that because the GPIB-232CV implements a hardware handshake scheme as well as the XON/XOFF software handshake scheme if selected, serial data

will not be lost regardless of the serial buffer size you choose. The larger serial buffer size is simply provided as a means of capturing a larger percentage of the total RAM space for serial-input use. For example, if you were connecting an RS-232 device capable only of transmitting data to the GPIB-232CV, you would definitely want to use the 32 KB serial buffer to maximize the use of the available RAM space.

Using the SRQ Feature

If your GPIB system has GPIB devices other than the GPIB-232CV that need to transfer data, and it is important that the GPIB bus not be slowed down or hung waiting for the GPIB-232CV to either receive serial data to be passed along to the GPIB or accept more GPIB data because its GPIB input buffer is full, then the SRQ feature can be enabled. The SRQ feature will alert the GPIB Controller by asserting the GPIB signal **SRQ*** when the GPIB-232CV requires attention. The Controller can then determine the status of the GPIB-232CV by performing a serial poll and analyzing the response byte. In this way, the GPIB bus can be used by other devices until service is required by the GPIB-232CV.

To get maximum GPIB performance when very large amounts of data are sent to the GPIB-232CV, enable the SRQ feature and only send data amounts up to but not exceeding the GPIB input buffer size. The Controller can then unaddress the GPIB-232CV to listen and allow other devices to use the GPIB. When the GPIB-232CV has emptied out its GPIB input buffer, it will request service, indicating it is ready for more data. The Controller can then re-address the GPIB-232CV to listen and continue sending data in the manner described until all the data has been sent.

Enabling the SRQ Feature

The SRQ feature can be enabled by setting switch 3 of the configuration switch at location U22 to the ON position. When enabled, the GPIB-232CV will assert the **SRQ*** signal whenever either the GPIB input buffer becomes empty or the GPIB-232CV receives serial data that it needs to pass on to the GPIB port. **SRQ*** will be unasserted when the GPIB Controller performs a serial poll on the GPIB-232CV.

Conditions that Assert SRQ

When the SRQ feature is enabled, one of the conditions that causes a service request is when the GPIB-232CV serial input buffer is empty. Then, the GPIB-232CV receives a serial character to be sent along to the GPIB. The **SRQ*** signal is asserted to alert the GPIB Controller that the GPIB-232CV has data to send to a GPIB Listener. The GPIB-232CV can then be addressed to talk so that the data can be read out of the GPIB-232CV serial buffer. After all data has been read, the Controller can unaddress the GPIB-232CV to talk so that other devices can be addressed to transfer data on the bus.

The other condition on which **SRQ*** will be asserted, if enabled, is when the GPIB input buffer becomes empty. If very large amounts of data are sent over the GPIB to the GPIB-232CV (greater than the GPIB buffer size) and the serial device is a very slow data acceptor, the GPIB-232CV internal GPIB data buffer might become full. If this does occur, the **FULL** indicator on the front panel will illuminate and the GPIB transfer rate will slow to approximately the same rate as the serial device accepting the data. Since the maximum data transfer rate on the GPIB is only as fast as the slowest Listener, the GPIB system performance may become unacceptable if other GPIB devices need to transfer data on the bus.

Serial Poll Responses

If the GPIB-232CV is serial polled, its response byte will depend upon the status of the internal data buffers. If the serial input buffer is empty, bit one of the status byte will be set to 1. If the serial input buffer is not empty, bit one will be set to 0. If the GPIB input buffer is empty, bit zero of the status byte will be set to 1. If the GPIB input buffer is not empty, bit one will be set to 0. In all cases, bit six will be set to 1 if the GPIB-232CV is requesting service, and will be set to 0 otherwise.

Listen-Only Mode

The GPIB-232CV will be located at the GPIB address specified by switches 4 through 8 of the configuration DIP switch at location U22. The GPIB-232CV also has the ability to be configured as a listen-only device if all GPIB address switches are set to ON. In the listen-only mode, no addressing is required to make the GPIB-232CV a GPIB Listener and it cannot be unaddressed to listen. All data transferred on the GPIB will be accepted by the GPIB-232CV and output to the serial port (even if the data

was intended for another device). This configuration could be used to monitor all GPIB data bus activity. Notice that when the GPIB-232CV is configured as a listen-only device, it may not be serial polled.

Special Conditions in D Mode

If the GPIB-232CV receives the universal Device Clear (DCL) command or its listen address and the Selected Device Clear (SDC) command, the GPIB-232CV will clear its internal data buffers and reset to its power-up state. Neither Trigger nor Go To Local has any effect on the GPIB-232CV.

In D mode operation, the GPIB-232CV does not assert EOI when sending characters along to the GPIB. You can use bit 1 of the serial poll response byte to determine if there are characters waiting to be sent to the GPIB.

C Mode Operation

In C mode, the GPIB-232CV acts as the GPIB System Controller and asserts **IFC*** for 500 µs when the GPIB-232CV is powered on. The action of asserting **IFC*** for at least 100 µs initializes the GPIB and makes the System Controller Controller-In-Charge (CIC). After the GPIB-232CV becomes CIC, it sends out the GPIB listen address on U22 switches 4 through 8. If all address configuration switches are ON, no addressing will be performed. This is useful if you are talking to a listen-only device that does not require addressing. The GPIB-232CV will always assert **REN*** when addressing other devices.

All incoming serial data to the GPIB-232CV is stored in an internal data buffer until it is accepted by the GPIB device. All GPIB data sent to the GPIB-232CV is passed immediately to the serial port without being buffered.

Modes of Operation within C Mode

Four different modes of operation within C mode define how the GPIB device is to be addressed—time termination, <CR> termination, <LF> termination, and no-swap. In all modes, the GPIB device is addressed to listen after the GPIB-232CV becomes CIC and all data received via the serial port is buffered. The data is then passed along to the GPIB device. The four modes of operation define at what point the GPIB device needs to

be unaddressed to listen and addressed to talk so that data can be sent from the GPIB device to the GPIB-232CV.

Time Termination Mode

In time termination mode, the GPIB-232CV will address the GPIB device to talk if the GPIB-232CV serial input buffer becomes empty and no more serial characters are received for 300 ms. After this period of inactivity, the GPIB-232CV assumes that since no more serial data is being sent, the GPIB device might have data that it needs to send back to the GPIB-232CV. Any characters read from the GPIB port at this time will immediately be passed along to the serial port. When a serial character is received by the GPIB-232CV, it immediately re-addresses the GPIB device to listen and passes the received character to it. It will remain in this mode until its serial-input buffer becomes empty and no serial characters are received for 300 ms, at which time it will re-address the GPIB device to talk.

Time termination mode should be used for applications in which bidirectional communication is required and neither a <CR> or <LF> character is used to signal the end of a command string to the GPIB device.

<CR> or <LF> Termination Mode

If a command string to the GPIB instrument can be terminated with either a <CR> or <LF> character, you can use either <CR> or <LF> termination mode to address the GPIB device to send data. In these modes, when the GPIB-232CV receives the terminating character, it will address the GPIB device to talk so that any GPIB data can be input by the GPIB-232CV. Any serial character received by the GPIB-232CV at this point will signal the GPIB-232CV to re-address the GPIB device as a Listener. For example, let's say you wish to connect an HP7475 GPIB plotter to an IBM-PC serial port via the GPIB-232CV and you want to draw a line, get plotter status, and then draw a circle. In BASIC, this could be done with the following commands:

```
10 OPEN "COM1:9600,n,8,1" AS #1   'Assumes
                                  'GPIB-232CV is
                                  'at 9600 baud,
                                  'no parity, 8
                                  'data bits, 1
                                  'stop bit.

20 PRINT #1,"pa1000,1000 os"      'Plot absolute to
                                  '1000,1000 then
                                  'output status.

30 LINE INPUT #1,RESPONSE$        'Get status
                                  'response from
                                  'plotter.

40 PRINT #1 "ci100";              'Draw circle
                                  'with radius of
                                  '100 units.
```

Notice that on line 20, the program outputs plotter commands to the serial port to both draw a line and obtain status. Since neither a <CR> nor <LF> was sent between these commands, the GPIB-232CV will keep the GPIB plotter addressed to listen and will send all serial data received to the plotter. Since the PRINT statement is not ended with a semicolon after the double quotation mark, BASIC will automatically send a <CR> after the last character in the ASCII string has been sent. Therefore, if the GPIB-232CV is set up for <CR> termination, the GPIB-232CV would at this time re-address the plotter to talk so that the status could be output. Line 30 will input the status response from the plotter into a string variable `RESPONSE$`. Line 40 will then output the plotter command to draw a circle to the GPIB-232CV. As soon as the GPIB-232CV receives the first character in this string, it will re-address the plotter to listen before sending these characters to the plotter. Notice that for this PRINT statement a semicolon was included after the last double quotation mark so that a <CR> will not be sent. Since information was not requested from the plotter, there is no need to send a <CR> at the end of the string to address the plotter to talk.

No-Swap Mode

In the last mode, no-swap, the GPIB-232CV will never re-address the GPIB device after it has initially addressed it to be a Listener. This mode is useful if your GPIB device is intended only to receive data. In the above example, you could use the no-swap mode to talk to the plotter if you never need to obtain status information from it.

Buffering and Handshaking

Two protection mechanisms are used to ensure that the GPIB-232CV does not lose incoming serial data: data buffering and handshaking.

The GPIB-232CV has an internal RAM buffer that stores incoming serial data until it can output the data to the GPIB port. The size of this RAM buffer, in part, determines how much serial data the GPIB-232CV can accept until its buffer overflows. The GPIB-232CV comes equipped with a 256 KB RAM buffer.

When its RAM buffer is nearly full, the GPIB-232CV can handshake with the serial host to stop data transmission. When the buffer is almost empty, the GPIB-232CV can again handshake with the serial host to start data transmission. The GPIB-232CV is capable of using both the XON/XOFF and the hardware handshaking protocols. The hardware handshake is always active during RS-232 transfers. The XON/XOFF protocol is enabled or disabled by properly setting the internal configuration switch.

Hardware Handshake

The hardware handshake function is always active during RS-232 transfers and uses the RTS and CTS signal lines. When the GPIB-232CV is ready to accept serial data, it asserts the RTS line. This signal remains asserted until the GPIB-232CV's data buffer is almost full. At this point, the GPIB-232CV unasserts the RTS line, signaling to the serial host that the GPIB-232CV is no longer ready to accept data. The serial host should monitor the RTS line and suspend data transmission whenever the RTS line becomes unasserted.

The GPIB-232CV is also able to suspend transmission when the serial host is no longer ready to accept data. The GPIB-232CV is configured to immediately stop transmission of serial data when CTS becomes unasserted.

Note: ***If you use a serial cable that does not connect to CTS, CTS will not be asserted and the GPIB-232CV will not transmit data.***

XON/XOFF

If your serial device does not recognize the hardware handshake scheme, or if your application software uses the XON/XOFF handshake scheme, it may be necessary to enable the XON/XOFF handshaking protocol. This handshaking protocol performs the same function as the hardware handshake but does so by sending special control codes over the data lines instead of by changing logic levels on dedicated control lines.

When you enable the XON/XOFF protocol, the GPIB-232CV sends the XOFF character (decimal 19 or <CTRL>s) when its internal buffer becomes full. Once the GPIB-232CV is able to start receiving characters again, it sends the XON character (decimal 17 or <CTRL>q). Similarly, if the GPIB-232CV is transmitting data and receives the XOFF character, it suspends transmission of any further data until it receives the XON character.

Caution: ***Do not use XON/XOFF handshaking if you are transmitting binary data. Because your data could include decimal 17 or 19 (<CTRL>q or <CTRL>s), the GPIB-232CV might handshake erratically.***

Appendix A
Hardware Specifications

This appendix lists the electrical, environmental, and physical specifications of the GPIB-232CV.

Table A-1. Electrical Characteristics

Characteristic	Specification
Power Supply Unit	Wall mount type, 115 VAC or 230 VAC, 50/60 Hz input, 9 VDC @ 1A max output
Voltage	9 VDC regulated
Current	640 mA typical; 750 mA max

Table A-2. Environmental Characteristics

Characteristic	Specification
Operating Temperature	10° to 40° C
Storage Temperature	0° to 70° C
Relative Humidity	10% to 95% noncondensing conditions
Noise Emissions	FCC Class A Verified

Table A-3. Physical Characteristics

Characteristic	Specification
Case Size	1.6 in. by 5.7 in. by 8.4 in. (40.6 mm by 144.8 mm by 213.4 mm)
Case Material	All metal enclosure
Rack Mounting	Single or dual kits available
Weight	28 oz. (without power supply unit)

Appendix B
Interfacing to a Serial Device

This appendix contains information about the RS-232 port and how to connect the GPIB-232CV to your serial device. This information is useful if you want to build your own serial cable

The GPIB-232CV transfers serial data using the electrical signals, the mechanical connections, and the data format and control protocols as defined in the RS-232C standard. The RS-232 port on the GPIB-232CV provides an asynchronous serial communication link to the host serial peripheral device. The RS-232 connector is located on the rear panel of the GPIB-232CV.

The RS-232C Standard

The RS-232C standard (international standard CCITT V.24) was formulated in 1969 largely from the efforts of the Electronic Industries Association (EIA) and Bell Laboratories. The standard describes the electrical specifications and arrangement of control and data signals on both sides of a serial communications interface. Its original intent was to interface terminals to modems. Many manufacturers of computers and instruments have adopted the standard for their serial communications needs. For more information on the RS-232 standard, contact

Global Engineering Documents
2805 McGaw Avenue
Irvine, CA 92714
(714) 261-1455

The RS-232C Serial Port

The RS-232 serial port on the GPIB-232CV uses a female 25-pin D-subminiature connector with a DTE (Data Terminal Equipment) interface configuration. That is, the GPIB-232CV transmits data on pin 2 and receives data on pin 3. Table B-1 shows the signal lines supported on the GPIB-232CV.

Table B-1. RS-232 Serial Port Signals

RS-232 Name	Pin	Signal Name	Function
AA	1	PG (Protective Ground)	This line is connected to the chassis ground of the GPIB-232CV. Since the chassis ground is not connected to earth ground, pin 1 should be connected on both serial devices.
BA	2	TxD (Transmit Data)	This line carries serial data from the GPIB-232CV to the serial host.
BB	3	RxD (Receive Data)	This line carries serial data from the serial host to the GPIB-232CV.
CA	4	RTS (Request to Send)	This signal line is driven by the GPIB-232CV and when asserted indicates that the GPIB-232CV is ready to accept serial data. The GPIB-232CV unasserts RTS when it is no longer ready to accept serial data because the buffer is full.
CB	5	CTS (Clear to Send)	This signal line is asserted by the serial host and sensed by the GPIB-232CV. When asserted, it indicates that the serial host is ready to accept serial data. When unasserted, it indicates that data transmission should be disabled.
AB	7	SG (Signal Ground)	This line establishes a reference point for all interface voltages.
CD	20	DTR (Data Ready)	This signal line is asserted by the GPIB-232CV to signal that it has been powered on and is ready to operate.

To interface other products to the GPIB-232CV serial port, consult your manual on that serial device to determine if the device is configured as a DTE or DCE. Also, notice how the control lines are used and whether they must be driven for the serial port to operate. The GPIB-232CV CTS signal is configured so that it must be asserted for the GPIB-232CV to transmit data.

Interfacing the GPIB-232CV to a DCE

A correctly configured DTE-to-DCE interface is wired straight across: GPIB-232CV pin 2 to DCE pin 2, pin 3 to pin 3, and so forth. Wired in this manner, the GPIB-232CV can then interact to function properly on buffer full conditions (handshake). Figure B-1 shows a properly configured DTE-to-DCE cable.

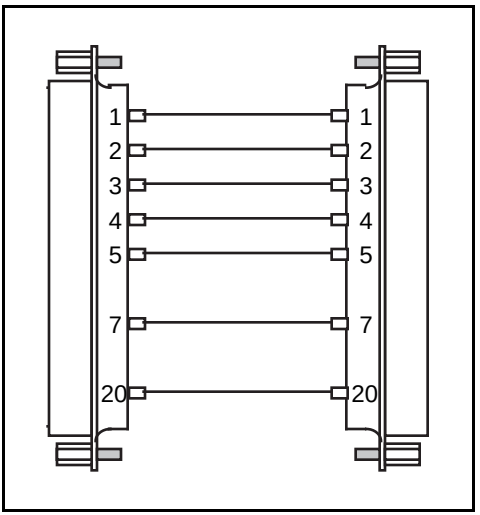

Figure B-1. DTE-to-DCE Cable Configuration

If your serial device does not use the same hardware handshaking protocol as the GPIB-232CV, you can either use a minimum configuration cable and use XON/XOFF handshaking (if necessary), or wire a custom cable that will satisfy the GPIB-232CV hardware handshaking protocol. The connections for a minimum configuration cable are shown in Figure B-2. The GPIB-232CV connector is on the left. (Assumes that the DCE's handshaking is satisfied internally.)

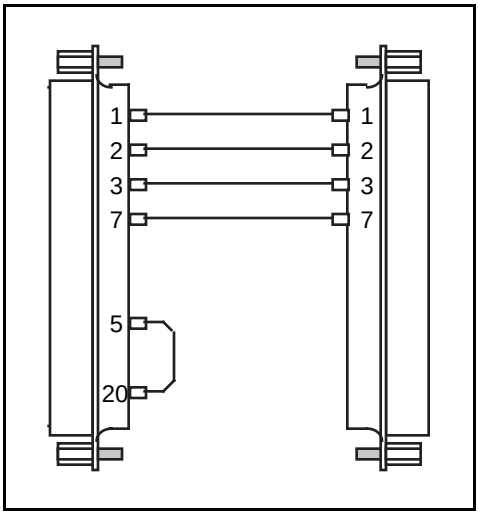

Figure B-2. Minimum DTE-to-DCE Cable Configuration

If your application requires a custom cable, review your serial device's RS-232 characteristics and build the cable to perform the desired functions.

Interfacing the GPIB-232CV to a DTE

For serial devices set up as DTEs, you must wire a DTE-to-DTE interface cable, commonly known as a null modem cable. The cable must fool the GPIB-232CV into thinking it is communicating with a DCE. Figure B-3 shows a typical null modem cable.

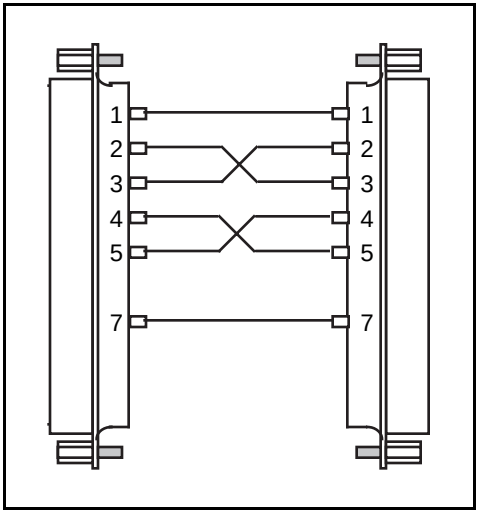

Figure B-3. Null Modem Cable Configuration

If your serial device does not use the same hardware handshaking protocol as the GPIB-232CV, you can either use a minimum configuration null modem cable and use XON/XOFF handshaking, or you can use a custom cable that will satisfy the GPIB-232CV hardware handshaking protocol. The connections for a minimum configuration null modem cable are shown in Figure B-4.

In Figure B-4, the GPIB-232CV connector is on the left. (Assumes the serial device's handshake is satisfied internally.)

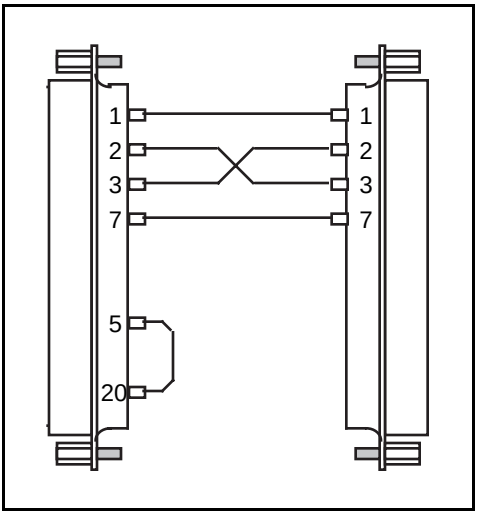

Figure B-4. Minimum Null Modem Cable Configuration

If a custom cable is required for your application, review your serial device's RS-232 characteristics and build the cable to perform the desired functions.

Appendix C
Application Examples

This appendix contains two GPIB-232CV application examples. The first example shows how to use the GPIB-232CV as a high-speed print spooler, and the second example shows how to connect a HP7475 GPIB plotter to an IBM PC running AUTOCAD.

Using the GPIB-232CV as a High-Speed Print Spooler

Because mechanical printers and plotters are slow relative to the processing speed of a computer, computers must output data at a slow rate. This forces you to wait for the data to be output or tolerate decreased performance if the data transfer occurs in the background. One common solution to this problem is to use a print spooler to relieve the computer of this task.

Standard print spoolers are able to store incoming data in a RAM buffer until the printer or plotter is able to accept it, allowing the PC to output data at a rate faster than printer or plotter rates. You can use the GPIB-232CV in this way.

With a GPIB-232CV, you can transfer data at GPIB rates instead of RS-232 rates. The GPIB-232CV uses a DMA Controller to input data from the GPIB port to the RAM buffer and can input GPIB data at rates up to 900 kbytes/sec. Therefore, the transfer rate is limited only by the rate at which the GPIB Talker can write data.

This example shows you how to connect and use your GPIB-232CV as a high-speed print spooler which returns control to you quickly, so that you do not have to wait for the PC to finish printing or plotting a file.

The following example is based on the assumption that a National Instruments GPIB interface board (such as the AT-GPIB) is installed in your computer and that you are familiar with the software configuration utility `ibconf`. Use the following procedure to set up the system the first time.

1. Use `ibconf` to configure the system so that a device named either *printer* or *plotter* is connected to the GPIB interface board. Be sure to enable DMA transfers and to use high-speed timing.

2. Configure the GPIB-232CV to operate in D mode with the small (256 bytes) serial port buffer and SRQ disabled. The serial buffer is set to the smallest size to allow the GPIB port, which is the data source, to use the majority of RAM. Set the GPIB address to the same address assigned to the device plotter or printer in `ibconf`. Configure the serial port parameters to match those of the printer or plotter.

3. Connect the GPIB cable from the PC to the GPIB-232CV, and connect the serial cable from the GPIB-232CV to the printer or plotter. The system should resemble the diagram in Figure C-1.

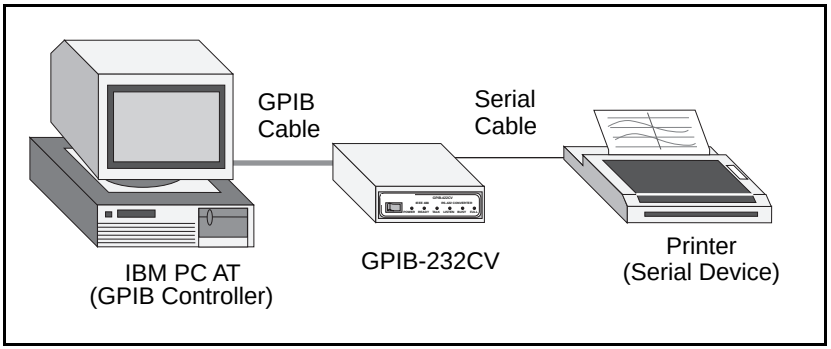

Figure C-1. Example of Print Spooler Setup

4. Provide a means to transfer data to the printer or plotter easily via the GPIB port on your PC. You can simply redirect the serial output to the GPIB device as explained in the *NI-488.2 Software Reference Manual for MS-DOS* which is provided with the National Instruments AT-GPIB board, but the overhead associated with the DOS calls makes this method inherently slow. The fastest way to transfer data to the GPIB port is to write a small program that executes a GPIB file write. The following program is an example of how to do a GPIB file write in the C programming language. You can use other languages in the same way.

```
/* FASTPRINT - dumps specified data file out GPIB
to device named printer */

#include "decl.h"
#include <stdio.h>

main (argc, argv)
char **argv;
{
   char fname [16],*filename;
   int f;

/* prompt for file name if not provided */
   if (argc <=1) {
        printf ("Enter filename:  ");
        gets (fname);
        filename = fname;
   }
   else
        filename = argv[1]

/* find device printer */
   if ((f = ibfind ("printer"))<0) {
        fprintf(stderr, "Can't find printer\n");
        exit(1);
   }


/* write file */
   if (ibwrtf(f, filename) & ERR) {
        fprintf(stderr, "Can't open %s\n", argv[1]);
        exit(1);

   }
}
```

After the program is compiled and linked, you can run it just like the DOS print routine. Then, as long as you are not sending an amount of data greater than the buffer size of the GPIB-232CV, the data transfer should complete in a few seconds.

Using the GPIB-232CV to Connect a HP7475 GPIB Plotter to a PC Serial Port

Many software packages provide printing and plotting utilities which use your computer's serial port. If GPIB support is not specifically provided in the package, you *cannot* communicate with a GPIB device. By using the GPIB-232CV, you can avoid this situation because the GPIB-232CV allows communication between the serial port and GPIB devices.

For example, an IBM PC running AUTOCAD sends data to the plotter by transferring data through the computer's serial port. It cannot send data to a GPIB plotter such as the HP7475 GPIB plotter. Because AUTOCAD supports the HP7475 *serial* plotter, you can use the GPIB-232CV to convert the serial data from AUTOCAD into GPIB data for the plotter. The GPIB-232CV automatically takes care of the GPIB addressing and transparently converts the data from one format to the other. To use the GPIB-232CV in this way, follow these steps:

1. Start AUTOCAD and select *Configure AUTOCAD* from the Main Menu. Select the HP7475 plotter and configure the rest of the operating parameters that you need.

2. Configure your GPIB-232CV. Set it to operate in C mode with timeout termination. Set the GPIB address of the plotter using the GPIB-232CV configuration switches. Set the serial port parameters to XON/XOFF disabled, 9600 baud, 7 data bits, 1 stop bit, and even parity.

3. Power on the plotter, then power on the GPIB-232CV.

When the GPIB-232CV is powered on, it addresses the GPIB plotter. Any data sent to the serial port by AUTOCAD is received by the GPIB-232CV and stored in its internal buffer. The GPIB-232CV transfers the data to the plotter over the GPIB connection as fast as the plotter can receive it. Because the GPIB-232CV provides a data buffer that spools the data as it is sent, the PC will be able to send data at serial rates instead of plotter rates. Therefore, your data is output to the GPIB plotter by AUTOCAD in less time than it would have taken to use the HP7475 serial plotter.

Appendix D
Customer Communication

For your convenience, this appendix contains forms to help you gather the information necessary to help us solve technical problems you might have as well as a form you can use to comment on the product documentation. Filling out a copy of the *Technical Support Form* before contacting National Instruments helps us help you better and faster.

National Instruments provides comprehensive technical assistance around the world. In the U.S. and Canada, applications engineers are available Monday through Friday from 8:00 a.m. to 6:00 p.m. (central time). In other countries, contact the nearest branch office. You may fax questions to us at any time.

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(512) 795-8248
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Spain	91 640 0085	91 640 0533
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	or 0800 289877 (in U.K. only)	

Technical Support Form

Photocopy this form and update it each time you make changes to your software or hardware, and use the completed copy of this form as a reference for your current configuration. Completing this form accurately before contacting National Instruments for technical support helps our applications engineers answer your questions more efficiently.

If you are using any National Instruments hardware or software products related to this problem, include the configuration forms from their user manuals. Include additional pages if necessary.

Name _____

Company _____

Address _____

_____

Fax (___)_____ Phone (___)_____

Computer brand _____

Model _____ Processor _____

Operating system _____

Speed _____MHz RAM _____MB

Display adapter _____

Mouse _____ yes _____ no

Other adapters installed _____

Hard disk capacity _____ MB Brand _____

Instruments used _____

National Instruments hardware product model _____

Revision _____

Configuration _____

(continues)

National Instruments software product _____

Version _____

Configuration _____

The problem is _____

_____

_____

_____

_____

_____

_____

_____

List any error messages _____

_____

_____

_____

_____

_____

_____

_____

The following steps will reproduce the problem _____

_____

_____

_____

_____

_____

_____

GPIB-232CV Hardware and Software Configuration Form

Record the settings and revisions of your hardware and software on the line to the right of each item. Update this form each time you revise your software or hardware configuration, and use this form as a reference for your current configuration.

National Instruments Products

- GPIB-232CV Model _____
- U20 Switch Setting _____
- U22 Switch Setting _____

Other Products

- Operating System and Version _____
- Application Programming Language _____
- Other Devices in System _____
- Serial Cable Wiring Diagram:

Documentation Comment Form

National Instruments encourages you to comment on the documentation supplied with our products. This information helps us provide quality products to meet your needs.

Title: **GPIB-232CV User Manual**

Edition Date: **April 1994**

Part Number: **320109-01**

Please comment on the completeness, clarity, and organization of the manual.

(continues)

If you find errors in the manual, please record the page numbers and describe the errors.

_____

_____

_____

_____

_____

_____

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Thank you for your help.

Name _____

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Glossary

Prefix	Meaning	Value
μ-	micro-	10^{-6}
m-	milli-	10^{-3}
k	kilo-	10^{3}
M-	mega-	10^{6}

°	degree
%	percent
A	amperes
C	Celsius
hex	hexadecimal
Hz	hertz
in	inches
KB	kilobytes of memory
m	meters
MB	megabytes of memory
oz	ounce
sec	seconds
V	volts
VAC	volts alternating current
VDC	volts direct current